

TRANSAPICAL AORTIC OCCLUSION FOR CARDIOPLEGIC DELIVERY DURING RECONSTRUCTION OF THORACOABDOMINAL AORTIC ANEURYSM WITH DEEP HYPOTHERMIC CIRCULATORY ARREST

Shiro Sasaguri, MD, Tomonobu Fukuda, MD, Taira Yamamoto, MD, Kinya Nishimura, MD, Kazunori Kudo, CCP, Masahiro Goto, MD, and Yasuyuki Hosoda, MD, *Tokyo, Japan*

The deep hypothermic circulatory arrest (DHCA) technique is currently used during reconstruction of the descending and thoracoabdominal aorta to prevent spinal cord injury. With this procedure, however, cardioplegic arrest for myocardial protection may not be obtainable through the left thoracotomy. Early reperfusion of the heart and brain after the completion of a proximal aortic anastomosis through the side branch of the graft may eliminate the ischemic cardiac and cerebral injury. However, prolonged cardiac fibrillation during the reconstruction of the intercostal arteries and visceral branches after the proximal anastomosis may deteriorate the myocardial function, especially in diseased heart cases. Recently, we developed a double-lumen balloon catheter that is inserted from the left ventricular apex for occlusion of the ascending aorta and cardioplegic delivery during the reconstruction of a thoracoabdominal aortic aneurysm through the left thoracotomy.

An operative technique. The aortic occlusion catheter (model 10F-60; Ideas for Medicine, Inc, St Petersburg, Fla) was devised for cardioplegic delivery through the left ventricular apex. The tip of the balloon catheter is occluded by glue, and a small side hole is located just beneath the balloon, enabling the cardioplegic solution in close proximity to the balloon to be flushed (Fig 1, A). The balloon can be inflated up to 48 mm in diameter with 50 mL of saline solution. The occlusion balloon can be inserted through the left ventricular apex, into the ascending aorta, guided by a transesophageal echocardiogram (Fig 1, B). This method had been applied in 2 cases. One patient, a 76-year-old man, had a thoracoabdominal aneurysm (Crawford classification; type III) complicated by an abdominal aortic dissection originating from the aneurysm. The other patient, a 67-year-old woman, had a chronic type III aortic dissection. She had undergone a previous operation to replace the proximal descending aorta. In both patients, the thoracoabdominal aorta was exposed by the extraperitoneal approach with a left thoracotomy through the seventh intercostal space, and cardiopulmonary bypass was initiated through the femorofemoral bypass. The left side of the heart

was vented via the left inferior pulmonary vein. Once the heart had fibrillated, the occlusion balloon catheter was inserted through a purse-string suture on the left ventricular apex and introduced into the ascending aorta. After inflation of the balloon, which was monitored by transesophageal echocardiography to occlude the ascending aorta appropriately (Fig 2), cardioplegic solution was infused through the side hole just beneath the balloon and cardiac arrest was obtained. At a rectal temperature of 20°C, DHCA was instituted and a proximal anastomosis between the graft and the descending aorta was performed. After the completion of this anastomosis, the arch vessels were reperfused through the side branch of the graft, leaving the ascending aorta occluded by the balloon. Cardioplegic solution was infused every 30 minutes during the reconstruction of the intercostal arteries and visceral branches. After the reconstruction of the visceral branches, rewarming was started, and then the occlusion balloon was deflated and removed to reperfuse the heart. The distal anastomosis between the graft and the abdominal aorta was made, and the total bypass flow was restored through the side branch of the graft. Cardiopulmonary bypass was weaned easily without any cardiac events, and both patients recovered uneventfully.

Discussion. DHCA is a useful adjunct during an operation on the descending thoracic and thoracoabdominal aorta when severe aortic disease precludes the placement of clamps on the aorta.¹ Furthermore, hypothermia has a marked protective effect on the spinal cord and visceral organs during periods of aortic occlusion.² However, for patients who are undergoing DHCA through the left side of the chest, cardioplegic cardiac arrest under aortic crossclamping is not obtainable for technical and anatomic reasons. Although hypothermia also protects the myocardium, prolonged hypothermic fibrillatory arrest may impair the myocardial perfusion even if venting is performed, especially in the presence of a hypertrophied heart, aortic insufficiency, or coronary artery disease. The report by Kouchoukos and associates,³ stating that the main causes of 5 deaths out of 51 patients who underwent operations on the descending thoracic and thoracoabdominal aorta with the DHCA technique were associated with postoperative myocardial dysfunction, arouses the need for myocardial protection during DHCA. Early rewarming after the reinstitution of cardiopulmonary bypass flow to the head and heart, which may induce the defibrillation of the heart, is an alternative method to protect the myocardium during the reconstruction of the thoracoabdominal aorta. However, the ischemic spinal cord or visceral organs may have the deleterious effects by rewarming. Okita and associates⁴ developed the internal aortic occlusion method to infuse the cardioplegic solution dur-

From the Department of Thoracic and Cardiovascular Surgery, Juntendo University, Tokyo, Japan.

Received for publication Aug 13, 1998; accepted for publication Aug 28, 1998.

Address for reprints: Shiro Sasaguri, MD, Department of Thoracic and Cardiovascular Surgery, Juntendo University, 2-1-1 Hongo, Bunkyo-ku, Tokyo, 113, Japan

J Thorac Cardiovasc Surg 1999;117:186-8

Copyright © 1999 by Mosby, Inc.

0022-5223/99 \$8.00 + 0 12/54/94227

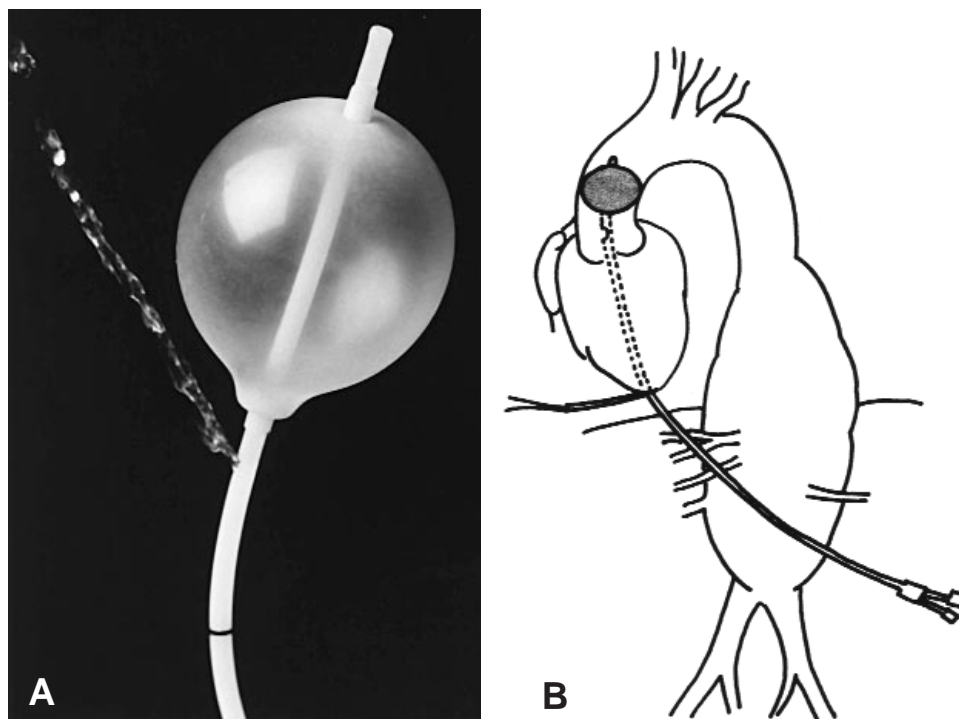


Fig 1. **A**, A flush of cardioplegic solution beneath the inflated balloon. **B**, Transapical aortic occlusion during reconstruction of thoracoabdominal aortic aneurysm with DHCA.



Fig 2. Transesophageal echocardiography during aortic occlusion. Inflated balloon in the ascending aorta (arrow).

ing the distal aortic arch reconstruction using a triple-lumen balloon catheter that is inserted from the cut end of the aortic arch. However, this method is applicable only for a distal aortic arch aneurysm and is not available for distal descending or thoracoabdominal aortic disease, because it may be difficult to introduce this balloon catheter into the ascending aorta far from the distal descending aorta. Furthermore, after the com-

pletion of the proximal anastomosis of the distal aortic arch, the balloon catheter that is inserted through the graft needs to be removed, with the result that prolonged cardiac fibrillation may be induced during the reconstruction of the intercostal arteries or visceral branches. Our newly developed double-lumen occlusion catheter can be introduced easily into the ascending aorta through the left ventricular apex. It protects

the heart by infusing the cardioplegic solution under aortic occlusion by means of the balloon throughout the procedure. Even though the balloon catheter passes through the aortic valve, significant aortic valve insufficiency is not likely to occur because of the small caliber of the balloon catheter. We believe that the clinical application of this double-lumen aortic occlusion catheter will protect the myocardium in patients with a thoracoabdominal aortic aneurysm or distal descending aortic aneurysm who undergo the operation through the left thoracotomy with DHCA.

REFERENCES

1. Kouchoukos NT, Wareing TH, Izumoto H, Klausling W, Abboud N. Elective hypothermic cardiopulmonary bypass and circulatory arrest for spinal cord protection during operations on the thoracoabdominal aorta. *J Thorac Cardiovasc Surg* 1990;99:659-64.
2. Rokkas CK, Sundaresan S, Shuman TA, Palazzo RS, Nitta T, Despotis GJ, et al. Profound systemic hypothermia protects the spinal cord in a primate model of spinal cord ischemia. *J Thorac Cardiovasc Surg* 1993;106:1024-35.
3. Kouchoukos NT, Daily BB, Rokkas CK, Murphy SF, Bauer S, Abboud N. Hypothermic bypass and circulatory arrest for operations on the descending thoracic and thoracoabdominal aorta. *Ann Thorac Surg* 1995;60:67-77.
4. Okita Y, Takamoto S, Ando M, Morota T, Kawashima Y. Utilization of triple-lumen balloon catheter for occlusion of the ascending aorta during distal aortic arch surgery with hypothermic circulation technique through left thoracotomy. *J Card Surg* 1995;10:699-702.

MODIFIED HEMI-FONTAN PROCEDURE ON THE BEATING HEART

Franz-Xaver Schmid, MD, Friedrich Wippermann, MD, Christoph Kampmann, MD, Michael Hilker, MD, and Hellmut Oelert, MD, Mainz, Germany

Indication, timing, and type of surgical intervention in patients with single ventricle physiologic condition are a continuing challenge. For patients who have significant risk factors for a poor Fontan outcome, the bidirectional cavopulmonary anastomosis has been shown to be an effective staging procedure by providing pulmonary blood flow without volume loading of the single ventricle.^{1,2} It offers the benefit of a relatively simple surgical approach and can be performed as a closed procedure with the heart beating on partial cardiopulmonary bypass. However, later completion of the Fontan circulation can only be accomplished by extensive dissection of the cardiac end of the superior vena cava and of the right atrium. Additionally, there may be an increased risk for arrhythmias and phrenic nerve palsy. Therefore the so-called hemi-Fontan procedure, including an anastomosis between both ends of the divided superior vena cava and the pulmonary artery in conjunction with an intraatrial patch occlusion of the cavoatrial junction, was introduced.³ This procedure involves opening of the right atrium during a short period of aortic crossclamping and cardioplegic arrest and

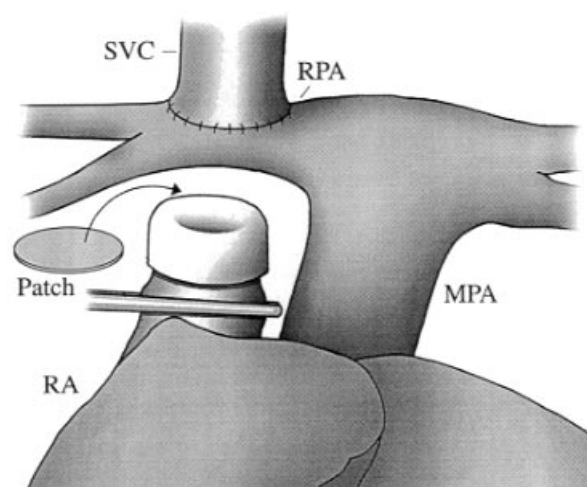


Fig 1. Schematic display of the operative procedure: Proximally eversion is facilitated by dissection and mobilization of the full length of the superior vena cava (SVC). RPA, Right pulmonary artery; MPA, main pulmonary artery; RA, right atrium.

From the Departments of Cardiothoracic Surgery and Pediatric Cardiology, Johannes Gutenberg-University Hospitals, Mainz, Germany.

Received for publication July 16, 1998; accepted for publication July 30, 1998.

Address for reprints: Franz-Xaver Schmid, MD, Department of Cardiothoracic Surgery, University Hospitals, Langenbeckstrasse 1, D-55131 Mainz, Germany.

J Thorac Cardiovasc Surg 1999;117:188-90

Copyright © 1999 by Mosby, Inc.

0022-5223/99 \$8.00 + 0 12/54/93616

may increase the overall risk of the operation. We developed an alternative technique for a hemi-Fontan procedure on cardiopulmonary bypass without the requirement for aortic crossclamping.

Technique. The operation is performed through a median sternotomy incision. Cardiopulmonary bypass is established by aortic perfusion and drainage via cannulation of the right atrium and the innominate vein. Clamps are placed on the